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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/593,918	08/06/2007	James M. Tour	11321-P086WOUS	5884

61060 7590 10/04/2010

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EXAMINER	
MARTINEZ, BRITTANY M	
ART UNIT	PAPER NUMBER
1793	
MAIL DATE	DELIVERY MODE
10/04/2010	PAPER

Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Office Action Summary	Application No.	Applicant(s)	
	10/593,918	TOUR ET AL.	
	Examiner	Art Unit	
	BRITTANY M. MARTINEZ	1793	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE *3* MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *09 July 2010*.

2a)☒ This action is **FINAL**. 2b)☐ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *1-32* is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *1-32* is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☒ The drawing(s) filed on *09 July 2010* is/are: a)☐ accepted or b)☒ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☐ Information Disclosure Statement(s) (PTO/SB/08) Paper No(s)/Mail Date _____.
4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____ .
5) ☐ Notice of Informal Patent Application
6) ☐ Other: _____.

DETAILED ACTION

Status of Application

Acknowledgment is made of Applicants' arguments/remarks and amendments filed July 9, 2010. **Claims 1-32** are pending in the instant application, with **Claims 1, 3-10, 12, 13, 16-20, 22, 24, 25 and 27** amended and **Claims 29-32** added. **Claims 1-32** have been examined.

Drawings

Figures 6, 7, 9a and 10 are objected to for being unclear and of insufficient quality for reprint in a patent publication. The portions of the figures that are completely blacked-out do not facilitate understanding of the invention and are essentially useless for illustration purposes if what is intended to be illustrated cannot even be seen in the figure. Refer to 37 CFR 1.84(b). Corrected drawing sheets in compliance with 37 CFR 1.121(d) are required in reply to the Office action to avoid abandonment of the application. Any amended replacement drawing sheet should include all of the figures appearing on the immediate prior version of the sheet, even if only one figure is being amended. The figure or figure number of an amended drawing should not be labeled as "amended." If a drawing figure is to be canceled, the appropriate figure must be removed from the replacement sheet, and where necessary, the remaining figures must be renumbered and appropriate changes made to the brief description of the several views of the drawings for consistency. Additional replacement sheets may be necessary

to show the renumbering of the remaining figures. Each drawing sheet submitted after the filing date of an application must be labeled in the top margin as either "Replacement Sheet" or "New Sheet" pursuant to 37 CFR 1.121(d). If the changes are not accepted by the examiner, the applicant will be notified and informed of any required corrective action in the next Office action. The objection to the drawings will not be held in abeyance.

Claim Rejections - 35 USC § 103

1. The text of those sections of Title 35, U.S. Code not included in this action can be found in a prior Office action.

2. **Claims 1, 2, 4, 5, 7, 8, 10, 12, 15 and 30** are rejected under 35 U.S.C. 103(a) as being unpatentable over Cooper et al. (US 2007/0084797 A1) (of record).

3. With regard to **Claims 1, 4 and 5**, Cooper discloses a method comprising dispersing carbon nanotubes in a liquid to form a solution of dispersed carbon nanotubes (Cooper, 0038), wherein the liquid may be water, oil, organic solvents, inorganic solvents, liquid nitrogen, liquid carbon dioxide, or acid (Cooper, 0046; 0124-0127; 0131); and functionalizing the dispersed carbon nanotubes using a functionalizing agent while the dispersed carbon nanotubes are in the liquid; wherein functionalizing comprises covalently attaching functional groups to the carbon nanotubes to form functionalized carbon nanotubes (Cooper, 0036; 0049-0050; 0053; 0117; 0119; 0124; 0131; Claims 141, 151, 152 and 154-159). Cooper further discloses the functionalized carbon nanotubes can comprise functional groups across the surface of the carbon

nanotubes and/or across at least one dimension of the nanostructured material (Cooper, 0053). Still further, Cooper discloses the carbon nanotubes can be treated in a solution of nitric and sulfuric acids to create functional groups on the carbon nanotubes (Cooper, 0124). While Cooper does not explicitly disclose the carbon nanotubes having substantially exposed sidewalls or the functionalizing comprising covalently attaching functional groups to the substantially exposed sidewalls to form sidewall functionalized carbon nanotubes, if the liquid of Cooper is an acid such as sulfuric or nitric acid, one of ordinary skill in the art would expect the carbon nanotubes to have substantially exposed sidewalls and the functionalizing to comprise covalently attaching functional groups to the substantially exposed sidewalls to form sidewall functionalized carbon nanotubes, to no less an extent than that of **Claim 1**.

4. With regard to **Claim 2**, Cooper discloses single-wall carbon nanotubes, multi-wall carbon nanotubes, and combinations thereof (Cooper, 0048).

5. With regard to **Claims 7, 8 and 10**, Cooper discloses the step of functionalizing involving a functionalizing agent selected from the group consisting of compounds including at least one chemical group selected from the group consisting of carboxyl, amine, polyamide, polyamphiphiles, diazonium salts, pyrenyl, silane and combinations thereof, fluorine compounds of boron, titanium, niobium, or tungsten, and halogenated compounds (Cooper, 0049-0051).

6. With regard to **Claim 12**, Cooper discloses at least one post-processing step selected from the group consisted of diluting, filtering, washing, drying, and combinations thereof (Cooper, 0126; 0174-0175; 0178; 0193; 0200; 0202).

7. With regard to **Claim 15**, Cooper does not explicitly disclose the functionalized carbon nanotubes having at least about 1 functional group per every 100 carbon nanotube carbons; however, if the liquid of Cooper is an acid such as sulfuric or nitric acid, the functionalized carbon nanotubes of Cooper would have at least about 1 functional group per every 100 carbon nanotube carbons since said carbon nanotubes would be functionalized by the same process, using the same materials as that of the instant application. The functionalized carbon nanotubes of Cooper would have at least about 1 functional group per every 100 carbon nanotube carbons to no less an extent than that of the instant application. Further, an expected functionalization amount/frequency is a result effective variable since one of ordinary skill in the art would expect different properties in the process and resulting product as such amount varies. Since the functionalization amount/frequency is a result effective variable, it is within the skill of one of ordinary skill in the art to develop a suitable functionalization extent/frequency for the carbon nanotubes. *In re Boesch*, 617 F.2d 272, 205 USPQ 215 (CCPA 1980).

8. With regard to **Claim 30**, Cooper discloses the functionalized carbon nanotubes are hydrophilic (water soluble) (Cooper, 0119).

9. **Claim 6** is rejected under 35 U.S.C. 103(a) as being unpatentable over Cooper et al. (US 2007/0084797 A1) (of record) as applied to **Claim 1** above, and further in view of Niu et al. (US 7,070,753 B2) (of record).

10. Cooper does not disclose the acid solvent further comprising a persulfate species (**Claim 6**).

11. With regard to **Claim 6**, Niu discloses a method comprising dispersing carbon nanotubes in a persulfate species to form dispersed carbon; and functionalizing the dispersed carbon nanotubes by covalently attaching functional groups to the sidewalls to yield sidewall functionalized carbon nanotubes (Niu, Abstract, Claims 1 and 5-7). The process of Niu increases the degree of dispersion of carbon nanotubes and aids in disassembling carbon nanotube aggregates (Niu, Abstract).

12. Thus, it would have been obvious to one of ordinary skill in the art to modify the process of Cooper with the persulfate species of Niu in order to obtain a dispersion of carbon nanotubes with a higher degree of dispersion (Niu, Abstract).

13. **Claim 9** is rejected under 35 U.S.C. 103(a) as being unpatentable over Cooper et al. (US 2007/0084797 A1) as applied to **Claims 1 and 8** above, and further in view of Dyke et al. (*JACS*), as applied in the previous Office action.

14. **Claim 11** is rejected under 35 U.S.C. 103(a) as being unpatentable over Cooper et al. (US 2007/0084797 A1) as applied to **Claims 1 and 8** above, and further in view of Csuzdi et al. (US 6,600,036 B2), as applied in the previous Office action.

15. **Claim 29** is rejected under 35 U.S.C. 103(a) as being unpatentable over Cooper et al. (US 2007/0084797 A1) (of record) as applied to **Claims 1 and 8** above, and further in view of Khabashesku et al. (US 7,125,533) (of record).

16. Cooper does not disclose the acid solvent further comprising a radical source (**Claim 29**).

17. With regard to **Claim 8**, Khabashesku discloses the use of acyl peroxides to generate radicals, which allows for the chemical attachment of a variety of functional groups to the wall of carbon nanotubes through covalent bonds without destroying the wall of the nanotubes (Khabashesku, Abstract; c. 7, l. 66-67; c. 8, l. 1-67; c. 9, l. 1-67; c. 10, l. 1-67; c. 11, l. 1-67; c. 12-c. 14; Examples). The radicals generated can have functional groups that provide sites for further reaction with other compounds, said reactive functional groups providing improved solvent dispersibility and providing reaction sites for monomers for incorporation in polymer structures (Khabashesku, Abstract).

18. Thus, it would have been obvious to one of ordinary skill in the art to modify the process of Cooper with the radical generating acyl peroxides of Khabashesku in order to obtain carbon nanotubes with improved solvent dispersibility (Khabashesku, Abstract).

19. **Claims 1-5, 7 and 12-15** are rejected under 35 U.S.C. 103(a) as being unpatentable over Khabashesku et al. (US 7,125,533) (of record) in view of Davis et al. (*Macromolecules*) (newly used).

20. With regard to **Claims 1 and 3-5**, Khabashesku discloses a method comprising dispersing carbon nanotubes in a solvent containing an acid to form dispersed carbon nanotubes (a slurry of nanotubes in acid), wherein the acid comprises H_2SO_4, H_3PO_4, HNO_3, oleum, chlorosulfonic acid, triflic acid, or combinations thereof (Khabashesku, c. 7, l. 66-67; c. 8, l. 1-9); and functionalizing the dispersed carbon nanotubes using a functionalizing agent such as dicarboxylic acid acyl peroxide (succinic acid peroxide or glutaric acid peroxide) while the dispersed carbon nanotubes are dispersed in a solvent (Khabashesku, c. 10, l. 60-67; c. 11, l. 1-67; c. 12, l. 1-67; c. 13, l. 1-27; c. 19, l. 39-59); wherein functionalizing comprises covalently attaching functional groups to the sidewalls to form sidewall functionalized carbon nanotubes (Khabashesku, Abstract; c. 3, l. 34-67; c. 4, l. 1-67; c. 7, l. 66-67; c. 8, l. 1-67; c. 9, l. 1-67; c. 10, l. 1-67; c. 11, l. 1-67; c. 12-c. 14; Examples; Claims 1-7; Figures 1-10). The difference between the process of Khabashesku and that of **Claim 1** is Khabashesku does not disclose the carbon nanotubes functionalized in the same acid solvent as they were initially dispersed in, the carbon nanotubes having substantially exposed sidewalls, or the functionalizing comprising covalently attaching functional groups to the substantially exposed sidewalls.

21. While the carbon nanotubes are functionalized in a solvent other than an acid in Khabashesku, the dispersion in which the carbon nanotubes are functionalized in contains a dicarboxylic acid acyl peroxide (succinic acid peroxide or glutaric acid peroxide) (Khabashesku, c. 10, l. 60-67; c. 11, l. 1-67; c. 12, l. 1-67; c. 13, l. 1-27; c. 19, l. 39-59) and thus, the carbon nanotubes are functionalized in an acid containing

solvent. While Khabashesku does not explicitly disclose the carbon nanotubes having substantially exposed sidewalls, the initial dispersion in an acid comprising H_2SO_4, H_3PO_4, HNO_3, oleum, chlorosulfonic acid, triflic acid, or combinations thereof, would produce carbon nanotubes having substantially exposed sidewalls to no less an extent than that of **Claim 1**. Thus, if the initial dispersion in an acid comprising H_2SO_4, H_3PO_4, HNO_3, oleum, chlorosulfonic acid, triflic acid, or combinations thereof, produces carbon nanotubes having substantially exposed sidewalls, functionalizing the sidewalls would comprise covalently attaching functional groups to the substantially exposed sidewalls.

22. With regard to **Claim 2**, Khabashesku discloses single-wall carbon nanotubes, multi-wall carbon nanotubes, and combinations thereof (Khabashesku, Abstract; Claims 1 and 5).

23. With regard to **Claim 7**, Khabashesku discloses the functionalizing agent comprising carbon radicals (Khabashesku, Abstract; c. 7, l. 66-67; c. 8, l. 1-67; c. 9, l. 1-67; c. 10, l. 1-67; c. 11, l. 1-67; c. 12-c. 14; Examples; Claims 1-7).

24. With regard to **Claim 12**, Khabashesku discloses at least one post-processing step selected from the group consisted of diluting, filtering, washing, drying, and combinations thereof (Khabashesku, Abstract; c. 7, l. 66-67; c. 8, l. 1-67; c. 9, l. 1-67; c. 10, l. 1-67; c. 11, l. 1-67; c. 12-c. 14; Examples).

25. With regard to **Claim 13**, Khabashesku discloses isolating the sidewall functionalized carbon nanotubes from the acidic medium by filtering to yield isolated sidewall functionalized carbon nanotubes; and resuspending the isolated sidewall functionalized carbon nanotubes in a solvent (Khabashesku, Examples 2 and 5).

26. With regard to **Claim 14**, Khabashesku discloses water as the solvent (Example 5).

27. With regard to **Claim 15**, Khabashesku discloses a maximum degree of functionalization of single-wall carbon nanotubes being one functional group per two single-wall nanotube carbons (Khabashesku, c. 9, l. 28-34 and 47-64; Tables 1 and 2).

28. With regard to **Claims 1 and 3-5**, Davis discloses single-walled carbon nanotubes can be dispersed at high concentrations in superacids such as oleum, chlorosulfonic acid, triflic acid, sulfuric acid, and combinations thereof (Davis, Abstract; p. 154; p. 159, "Conclusions"). Davis discloses that "the lack of a liquid able to disperse significant amounts of pristine SWNTs has been the single most important roadblock to manufacturing macroscopic articles composed solely of SWNTs" (Davis, p. 154, 1st column, 1st paragraph). However, SWNTs can be dispersed at concentrations up to 10 wt% in superacids, a concentration "over 10 times the highest concentration ever achieved with wrapping or stabilization by surfactants" (Davis, p. 154, 1st column, 2nd paragraph). The high dispersed carbon nanotube concentration in superacids is due to the protonation of the sidewalls of the SWNTs, which eliminates wall-wall van der Waals interactions and promotes the dispersion process (Davis, Abstract; p. 154, 1st column, 2nd paragraph – 2nd column, 1st paragraph). Thus, it would have been obvious to one of ordinary skill in the art to modify the process of Khabashesku with the superacid of Davis in order to obtain a high concentration of dispersed carbon nanotubes (Davis, Abstract; p. 154, 1st column – 2nd column, 1st paragraph).

29. **Claim 6** is rejected under 35 U.S.C. 103(a) as being unpatentable over Khabashesku et al. (US 7,125,533) (of record) in view of Davis et al. (*Macromolecules*) (newly used) as applied to **Claim 1** above, and further in view of Niu et al. (US 7,070,753 B2) (of record).

30. The aforementioned applied art does not disclose the acid solvent further comprising a persulfate species (**Claim 6**).

31. With regard to **Claim 6**, Niu is applied as above.

32. Thus, it would have been obvious to one of ordinary skill in the art to modify the process of the aforementioned applied art with the persulfate species of Niu in order to obtain a dispersion of carbon nanotubes with a higher degree of dispersion (Niu, Abstract).

33. **Claims 1, 2, 4, 5, 7-10, 12 and 15** are rejected under 35 U.S.C. 102(b) as being anticipated by Dyke et al. (*JACS*) (of record).

34. With regard to **Claims 1, 4 and 5**, Dyke discloses a method comprising dispersing carbon nanotubes in an acid such as H_2SO_4 to form dispersed carbon nanotubes (Dyke, p. 1156; Scheme 1); and functionalizing the dispersed carbon nanotubes using a functionalizing agent while the dispersed carbon nanotubes are in the acid; wherein functionalizing comprises covalently attaching functional groups to the sidewalls to form sidewall functionalized carbon nanotubes (Dyke, p. 1156; Scheme 1). The difference between the process of Dyke and that of **Claim 1** is Dyke does not disclose the acid as a solvent (and actually teaches a “solvent-free” process), the

carbon nanotubes having substantially exposed sidewalls, or the functionalizing comprising covalently attaching functional groups to the substantially exposed sidewalls. However, calling the acid a "solvent" is a matter of semantics. The H_2SO_4 of Dyke would be an “acid solvent” to no less an extent than that of the instant application.

35. While Dyke does not explicitly disclose the carbon nanotubes having substantially exposed sidewalls, the dispersion in H_2SO_4 would produce carbon nanotubes having substantially exposed sidewalls to no less an extent than that of **Claim 1**. Thus, if the dispersion in H_2SO_4 produces carbon nanotubes having substantially exposed sidewalls, functionalizing the sidewalls would comprise covalently attaching functional groups to the substantially exposed sidewalls.

36. With regard to **Claim 2**, Dyke discloses single-wall carbon nanotubes, multi-wall carbon nanotubes and combinations thereof (Dyke, p. 1156-1157).

37. With regard to **Claims 7-10**, Dyke discloses the step of functionalizing involving a diazonium species provided as a diazonium salt or generated *in situ* by reaction of an aniline species with a nitrite species (Dyke, p. 1156).

38. With regard to **Claim 12**, Dyke discloses at least one post-processing step selected from the group consisted of diluting, filtering, washing, drying, and combinations thereof (Dyke, p. 1156).

39. With regard to **Claim 15**, Dyke does not explicitly disclose the functionalized carbon nanotubes having at least about 1 functional group per every 100 carbon nanotube carbons; however, the functionalized carbon nanotubes of Dyke would have at least about 1 functional group per every 100 carbon nanotube carbons since Dyke

discloses the same process using the same materials as that of the instant application. The functionalized carbon nanotubes of Dyke would have at least about 1 functional group per every 100 carbon nanotube carbons to no less an extent than that of the instant application. Further, an expected functionalization amount/frequency is a result effective variable since one of ordinary skill in the art would expect different properties in the process and resulting product as such amount varies. Since the functionalization amount/frequency is a result effective variable, it is within the skill of one of ordinary skill in the art to develop a suitable functionalization extent/frequency for the carbon nanotubes. *In re Boesch*, 617 F.2d 272, 205 USPQ 215 (CCPA 1980).

40. **Claim 6** is rejected under 35 U.S.C. 103(a) as being unpatentable over Dyke et al. (*JACS*) (of record) as applied to **Claim 1** above, and further in view of Niu et al. (US 7,070,753 B2) (of record).

41. Dyke does not disclose the acid solvent further comprising a persulfate species (**Claim 6**).

42. With regard to **Claim 6**, Niu is applied as above.

43. Thus, it would have been obvious to one of ordinary skill in the art to modify the process of Dyke with the persulfate species of Niu in order to obtain a dispersion of carbon nanotubes with a higher degree of dispersion (Niu, Abstract).

44. **Claims 16-20, 22-28, 31 and 32** are rejected under 35 U.S.C. 103(a) as being obvious over Khabashesku et al. (US 7,125,533) (of record) in view of Davis et al.

(*Macromolecules*) (newly used) and Cooper et al. (US 2007/0084797 A1) (of record), and further in view of Dyke et al. (*JACS*) (of record).

45. With regard to **Claim 16**, Khabashesku discloses a method comprising dispersing carbon nanotubes in a solvent containing an acid to form dispersed carbon nanotubes (a slurry of nanotubes in acid), wherein the acid comprises H_2SO_4, H_3PO_4, HNO_3, oleum, chlorosulfonic acid, triflic acid, or combinations thereof (Khabashesku, c. 7, l. 66-67; c. 8, l. 1-9); and functionalizing the dispersed carbon nanotubes using a functionalizing agent such as dicarboxylic acid acyl peroxide (succinic acid peroxide or glutaric acid peroxide) while the dispersed carbon nanotubes are dispersed in a solvent (Khabashesku, c. 10, l. 60-67; c. 11, l. 1-67; c. 12, l. 1-67; c. 13, l. 1-27; c. 19, l. 39-59); wherein functionalizing comprises covalently attaching functional groups to the sidewalls to form sidewall functionalized carbon nanotubes (Khabashesku, Abstract; c. 3, l. 34-67; c. 4, l. 1-67; c. 7, l. 66-67; c. 8, l. 1-67; c. 9, l. 1-67; c. 10, l. 1-67; c. 11, l. 1-67; c. 12-c. 14; Examples; Claims 1-7; Figures 1-10). The difference between the process of Khabashesku and that of **Claim 16** is Khabashesku does not disclose adding aniline species and a nitrite species to the dispersion to form a diazonium species in the acid; or reacting the single-walled carbon nanotubes with the diazonium species while dispersed in the acid to form functionalized single-wall carbon nanotubes. While the carbon nanotubes are functionalized in a solvent other than an acid in Khabashesku, the dispersion in which the carbon nanotubes are functionalized in contains a dicarboxylic acid acyl peroxide (succinic acid peroxide or glutaric acid peroxide)

(Khabashesku, c. 10, l. 60-67; c. 11, l. 1-67; c. 12, l. 1-67; c. 13, l. 1-27; c. 19, l. 39-59) and thus, the carbon nanotubes are functionalized in an acid containing solvent.

46. With regard to **Claims 16 and 20**, Davis discloses single-walled carbon nanotubes can be dispersed at high concentrations in superacids such as oleum, chlorosulfonic acid, triflic acid, sulfuric acid, and combinations thereof (Davis, Abstract; p. 154; p. 159, "Conclusions"). Davis discloses that "the lack of a liquid able to disperse significant amounts of pristine SWNTs has been the single most important roadblock to manufacturing macroscopic articles composed solely of SWNTs" (Davis, p. 154, 1st column, 1st paragraph). However, SWNTs can be dispersed at concentrations up to 10 wt% in superacids, a concentration "over 10 times the highest concentration ever achieved with wrapping or stabilization by surfactants" (Davis, p. 154, 1st column, 2nd paragraph). The high dispersed carbon nanotube concentration in superacids is due to the protonation of the sidewalls of the SWNTs, which eliminates wall-wall van der Waals interactions and promotes the dispersion process (Davis, Abstract; p. 154, 1st column, 2nd paragraph – 2nd column, 1st paragraph). Thus, it would have been obvious to one of ordinary skill in the art to modify the process of Khabashesku with the superacid of Davis in order to obtain a high concentration of dispersed carbon nanotubes (Davis, Abstract; p. 154, 1st column – 2nd column, 1st paragraph).

47. With regard to **Claim 16**, Cooper discloses a method comprising dispersing carbon nanotubes in a liquid to form a solution of dispersed carbon nanotubes (Cooper, 0038), wherein the liquid may be water, oil, organic solvents, inorganic solvents, liquid nitrogen, liquid carbon dioxide, or acid (Cooper, 0046; 0124-0127; 0131); and

functionalizing the dispersed carbon nanotubes using a functionalizing agent while the dispersed carbon nanotubes are in the liquid; wherein functionalizing comprises covalently attaching functional groups to the carbon nanotubes to form functionalized carbon nanotubes (Cooper, 0036; 0049-0050; 0053; 0117; 0119; 0124; 0131; Claims 141, 151, 152 and 154-159), wherein the step of functionalizing involves diazonium salts (Cooper, 0049-0051).

48. Further, with regard to **Claim 16**, it is well-known in the art that diazonium species may be generated *in situ* by reaction of an aniline species with a nitrite species, and used in the functionalization of carbon nanotubes, as evidenced by Dyke (Dyke, p. 1156). Thus, it would have been obvious to one of ordinary skill in the art to try to modify the process of the aforementioned applied art with the diazonium species generated *in situ* by reaction of an aniline species with a nitrite species as taught by Dyke because one of ordinary skill in the art could have pursued the known potential diazonium species generation options within his or her technical grasp with a reasonable expectation of success.

49. With regard to **Claim 17**, Khabashesku discloses the single-wall carbon nanotubes oxidatively purified prior to dispersing (Khabashesku, Examples).

50. With regard to **Claim 18**, Khabashesku discloses sorting the single-wall carbon nanotubes by a property such as diameter prior to dispersing (procuring single-wall carbon nanotubes having an average diameter of about 1 nm) (Khabashesku, Examples).

51. With regard to **Claim 19**, Khabashesku discloses the step of filtering the dispersion to remove any large particles (Khabashesku, Examples).

52. With regard to **Claim 22**, Khabashesku discloses the solvent further comprising a radical source (Khabashesku, Abstract; c. 7, l. 66-67; c. 8, l. 1-67; c. 9, l. 1-67; c. 10, l. 1-67; c. 11, l. 1-67; c. 12-c. 14; Examples).

53. With regard to **Claim 23**, Khabashesku discloses the radical source being benzoyl peroxide (Khabashesku, Abstract; c. 7, l. 66-67; c. 8, l. 1-67; c. 9, l. 1-67; c. 10, l. 1-67; c. 11, l. 1-67; c. 12-c. 14; Examples).

54. With regard to **Claim 24**, Khabashesku discloses the step of reacting comprising heating and stirring the dispersion of carbon nanotubes and solvent (Khabashesku, Examples).

55. With regard to **Claim 25**, Khabashesku discloses diluting the reaction mixture with water, subsequent to forming functionalized single-wall carbon nanotubes, to form a diluted reaction product mixture; filtering the diluted reaction mixture over a filter to isolate the functionalized single-wall carbon nanotubes, and washing the isolated functionalized single-wall carbon nanotubes with a washing solvent to obtain washed functionalized single-wall carbon nanotubes (Khabashesku, Abstract; c. 7, l. 66-67; c. 8, l. 1-67; c. 9, l. 1-67; c. 10, l. 1-67; c. 11, l. 1-67; c. 12-c. 14; Examples).

56. With regard to **Claim 26**, Khabashesku discloses the washing solvent being acetone (Khabashesku, Examples).

57. With regard to **Claim 27**, Khabashesku discloses re-suspending the washed functionalized single-wall carbon nanotubes in water to form a re-suspension; and

filtering the re-suspension to recover rewashed functionalized single-wall carbon nanotubes (Khabashesku, Examples 2 and 5).

58. With regard to **Claim 28**, Khabashesku discloses a maximum degree of functionalization of single-wall carbon nanotubes being one functional group per two single-wall nanotube carbons (Khabashesku, c. 9, l. 28-34 and 47-64; Tables 1 and 2).

59. With regard to **Claim 31**, Cooper discloses the functionalized carbon nanotubes are hydrophilic (water soluble) (Cooper, 0119).

60. With regard to **Claim 32**, Khabashesku discloses the functionalized single-wall carbon nanotubes functionalized on their sidewalls (Khabashesku, Abstract).

61. **Claim 21** is rejected under 35 U.S.C. 103(a) as being obvious over Khabashesku et al. (US 7,125,533) (of record) in view of Davis et al. (*Macromolecules*) (newly used) and Cooper et al. (US 2007/0084797 A1) (of record), and further in view of Dyke et al. (*JACS*) (of record) as applied to **Claim 16** above, and further in view of Yu et al. (US 6,399,202 B1) (of record).

62. The aforementioned applied art does not disclose the aniline species comprising sulfanilic acid. However, sulfanilic acid is a well-known aniline species used to produce diazonium species, as evidenced by Yu (Yu, Examples). Thus, it would have been obvious to one of ordinary skill in the art to try to modify the process disclosed by the aforementioned applied art with the sulfanilic acid of Yu because one of ordinary skill in the art could have pursued the known potential aniline species used to produce

diazonium species within his or her technical grasp with a reasonable expectation of success.

63. **Claims 1-5, 7-10, 12, 13, 15-17, 19, 20, 24, 28 and 30-32** are rejected under 35 U.S.C. 103(a) as being unpatentable over Bahr et al. (*Chem. Mater.*) (newly cited) in view of Davis et al. (*Macromolecules*) (newly used).

64. With regard to **Claims 1-5, 7-9, 16, 20 and 32**, Bahr discloses a method comprising dispersing single-walled carbon nanotubes in a solvent to form a solution of dispersed single-walled carbon nanotubes; adding an aniline species and a nitrite species to the dispersion to form a diazonium species in the solvent; and reacting the single-walled carbon nanotubes with the diazonium species while dispersed in the solvent to form sidewall functionalized single-walled carbon nanotubes (Bahr, p. 3823-3824; Figure 1). The difference between the process of Bahr and that of **Claim 1** is Bahr does not disclose an acid solvent, the carbon nanotubes having substantially exposed sidewalls, or the functionalizing comprising covalently attaching functional groups to the substantially exposed sidewalls. The difference between the process of Bahr and that of **Claim 16** is Bahr does not disclose a superacid solvent.

65. With regard to **Claim 10**, Bahr discloses diazonium salts as known sources of diazonium species in the art (Bahr, p. 3824, 1st column).

66. With regard to **Claim 12**, Bahr discloses processing the sidewall functionalized carbon nanotubes by at least one post-processing step selected from the group

consisted of diluting, filtering, washing, and combinations thereof (Bahr, p. 3823, 2nd column, 2nd paragraph).

67. With regard to **Claim 13**, Bahr discloses isolating the sidewall functionalized carbon nanotubes from the solvent by filtering to yield isolated sidewall functionalized carbon nanotubes; and re-suspending the isolated sidewall functionalized carbon nanotubes in a solvent (Bahr, p. 3823, 2nd column, 2nd paragraph).

68. With regard to **Claims 15 and 28**, Bahr discloses 1 in 37 carbons in the nanotubes being functionalized (Bahr, p. 3824, 2nd column, 1st paragraph).

69. With regard to **Claim 17**, Bahr discloses oxidatively purifying the single-walled carbon nanotubes prior to dispersing (Bahr, p. 3823, 2nd column, 2nd paragraph).

70. With regard to **Claim 19**, Bahr discloses filtering the dispersion over a PTFE (0.45 μM) membrane (which would remove any large particles) (Bahr, p. 3823, 2nd column, 2nd paragraph).

71. With regard to **Claim 24**, Bahr discloses reacting comprising heating and stirring the dispersion (Bahr, p. 3823, 2nd column, 2nd paragraph).

72. Bahr does not disclose a superacid selected from the group consisting of oleum, chlorosulfonic acid, triflic acid, and combinations thereof (**Claims 3 and 20**); an oxoacid selected from the group consisting of H_2SO_4, H_3PO_4, $HClO_4$, HNO_3, and combinations thereof (**Claims 4 and 5**); or the sidewall functionalized carbon nanotubes being water soluble (**Claims 30 and 31**).

73. With regard to **Claims 1, 3-5, 16 and 20**, Davis is applied as above. Thus, it would have been obvious to one of ordinary skill in the art to modify the process of Bahr

with the superacid of Davis in order to obtain a high concentration of dispersed carbon nanotubes (Davis, Abstract; p. 154, 1st column – 2nd column, 1st paragraph).

74. Further, with regard to **Claim 1**, while the aforementioned applied art does not explicitly disclose the carbon nanotubes having substantially exposed sidewalls, the dispersion in superacid would produce carbon nanotubes having substantially exposed sidewalls to no less an extent than that of **Claim 1**. Thus, if the dispersion in superacid produces carbon nanotubes having substantially exposed sidewalls, functionalizing the sidewalls would comprise covalently attaching functional groups to the substantially exposed sidewalls.

75. With regard to **Claims 30 and 31**, the sidewall functionalized carbon nanotubes of the aforementioned applied art would be water soluble to no less an extent than that of the instant application since the sidewall functionalized carbon nanotubes of the aforementioned applied art are produced by the same process, using the same products of **Claims 1 and 16**.

76. **Claim 6** is rejected under 35 U.S.C. 103(a) as being unpatentable over Bahr et al. (*Chem. Mater.*) (newly cited) in view of Davis et al. (*Macromolecules*) (newly used) as applied to **Claim 1** above, and further in view of Niu et al. (US 7,070,753 B2) (of record).

77. The aforementioned applied art does not disclose the acid solvent further comprising a persulfate species (**Claim 6**).

78. With regard to **Claim 6**, Niu is applied as above.

79. Thus, it would have been obvious to one of ordinary skill in the art to modify the process of the aforementioned applied art with the persulfate species of Niu in order to obtain a dispersion of carbon nanotubes with a higher degree of dispersion (Niu, Abstract).

80. **Claim 21** is rejected under 35 U.S.C. 103(a) as being obvious over Bahr et al. (*Chem. Mater.*) (newly cited) in view of Davis et al. (*Macromolecules*) (newly used) as applied to **Claim 16** above, and further in view of Yu et al. (US 6,399,202 B1) (of record).

81. The aforementioned applied art does not disclose the aniline species comprising sulfanilic acid. However, sulfanilic acid is a well-known aniline species used to produce diazonium species, as evidenced by Yu (Yu, Examples). Thus, it would have been obvious to one of ordinary skill in the art to try to modify the process disclosed by the aforementioned applied art with the sulfanilic acid of Yu because one of ordinary skill in the art could have pursued the known potential aniline species used to produce diazonium species within his or her technical grasp with a reasonable expectation of success.

82. **Claim 29** is rejected under 35 U.S.C. 103(a) as being unpatentable over Bahr et al. (*Chem. Mater.*) (newly cited) in view of Davis et al. (*Macromolecules*) (newly used) as applied to **Claims 1 and 8** above, and further in view of Khabashesku et al. (US 7,125,533) (of record).

83. The aforementioned applied art does not disclose the acid solvent further comprising a radical source (**Claim 29**).

84. With regard to **Claim 8**, Khabashesku is applied as above.

85. Thus, it would have been obvious to one of ordinary skill in the art to modify the process of the aforementioned applied art with the radical generating acyl peroxides of Khabashesku in order to obtain carbon nanotubes with improved solvent dispersibility (Khabashesku, Abstract).

Double Patenting

The nonstatutory double patenting rejection is based on a judicially created doctrine grounded in public policy (a policy reflected in the statute) so as to prevent the unjustified or improper timewise extension of the "right to exclude" granted by a patent and to prevent possible harassment by multiple assignees. A nonstatutory obviousness-type double patenting rejection is appropriate where the conflicting claims are not identical, but at least one examined application claim is not patentably distinct from the reference claim(s) because the examined application claim is either anticipated by, or would have been obvious over, the reference claim(s). See, e.g., *In re Berg*, 140 F.3d 1428, 46 USPQ2d 1226 (Fed. Cir. 1998); *In re Goodman*, 11 F.3d 1046, 29 USPQ2d 2010 (Fed. Cir. 1993); *In re Longi*, 759 F.2d 887, 225 USPQ 645 (Fed. Cir. 1985); *In re Van Ornum*, 686 F.2d 937, 214 USPQ 761 (CCPA 1982); *In re Vogel*, 422 F.2d 438, 164 USPQ 619 (CCPA 1970); and *In re Thorington*, 418 F.2d 528, 163 USPQ 644 (CCPA 1969).

A timely filed terminal disclaimer in compliance with 37 CFR 1.321(c) or 1.321(d) may be used to overcome an actual or provisional rejection based on a nonstatutory double patenting ground provided the conflicting application or patent either is shown to be commonly owned with this application, or claims an invention made as a result of activities undertaken within the scope of a joint research agreement.

Effective January 1, 1994, a registered attorney or agent of record may sign a terminal disclaimer. A terminal disclaimer signed by the assignee must fully comply with 37 CFR 3.73(b).

86. **Claims 1, 2, 4, 5, 7-10, 15, 16, 24, 28 and 32** are rejected on the ground of nonstatutory obviousness-type double patenting as being unpatentable over Claims 1-5, 8, 11-20, 22 and 25 of U.S. Patent No. 7,459,137. Although the conflicting claims are not identical, they are not patentably distinct from each other because U.S. Patent No. 7,459,137 discloses a method for functionalizing carbon nanotubes comprising mixing (dispersing) carbon nanotubes in an acid selected from the group consisting of sulfuric acid, acetic acid, hydrochloric acid, nitric acid, phosphoric acid, toluenesulphonic acid, trifluoroacetic acid, and combinations thereof; and b) functionalizing the carbon nanotubes using a functionalizing agent while the carbon nanotubes are mixed in the solvent; wherein functionalizing comprises attaching functional groups to the sidewalls to form sidewall functionalized carbon nanotubes, substantially as in the instant application. While **Claim 1** of U.S. Patent No. 7,459,137 does recite "reacting said plurality of carbon nanotubes at the sidewall carbon atoms with an organic functionalizing agent in the absence of a solvent," the organic functionalizing agent is

further limited to “a reactive diazonium specie" (**Claim 11**) generated from an aryl diazonium salt (**Claim 12**), wherein the diazonium specie is generated in situ from an aniline derivative and an inorganic nitrite in the presence of an acid (**Claim 20**) selected from the group consisting of sulfuric acid, acetic acid, hydrochloric acid, nitric acid, phosphoric acid, toluenesulphonic acid, trifluoroacetic acid, and combinations thereof (**Claim 22**). Thus, if the carbon nanotubes of U.S. Patent No. 7,459,137 are sidewall functionalized using a functionalizing agent in the presence of an acid (**Claim 20**) selected from the group consisting of sulfuric acid, acetic acid, hydrochloric acid, nitric acid, phosphoric acid, toluenesulphonic acid, trifluoroacetic acid, and combinations thereof, calling the acid a "solvent" is a matter of semantics. The oxoacid of U.S. Patent No. 7,459,137 would be an “acid solvent” that disperses the carbon nanotubes to no less an extent than that of the instant application.

Response to Amendment

Applicants’ amendments with regard to the Specification, Claims and Drawings, filed July 9, 2010, have been carefully considered and are accepted. The Objection to Fig. 2 and the 35 U.S.C. 112, second paragraph, rejections of the previous Office action have been withdrawn. Applicants' amendment to Figures 6, 7, 9a and 10 does not overcome the Drawing Objection of the previous Office action because said figures are of insufficient quality for reprint in a patent publication. The portions of the figures that are completely blacked-out do not facilitate understanding of the invention and are

essentially useless for illustration purposes if what is intended to be illustrated cannot even be seen in the figure.

Response to Arguments

1. Applicants' arguments filed July 9, 2010, with regard to Cooper, Khabashesku, and Dyke (Applicants' Response, 7/9/10, p. 10-26) have been fully considered but they are not persuasive.

2. Acknowledgment is made of Applicants' arguments that Cooper does not teach functionalization of the carbon nanotube sidewalls in acid (Applicants' Response, 7/9/10, p. 11-13 and 20-26); however, the examiner respectfully disagrees. Cooper discloses dispersing carbon nanotubes in a liquid to form a solution of dispersed carbon nanotubes (Cooper, 0038), wherein the liquid may be inorganic solvents or acid (Cooper, 0046; 0124-0127; 0131); and functionalizing the dispersed carbon nanotubes using a functionalizing agent while the dispersed carbon nanotubes are in the liquid (Cooper, 0036; 0049-0050; 0053; 0117; 0119; 0124; 0131; Claims 141, 151, 152 and 154-159). Cooper discloses the functional groups are "generally located on the ends of the carbon nanotubes" (Cooper, 0052); however, this does not mean the functional groups are always located on the ends of the carbon nanotubes. Cooper discloses the functionalized carbon nanotubes can comprise functional groups across the surface of the carbon nanotubes and/or across at least one dimension of the nanostructured material (Cooper, 0053). Still further, Cooper discloses the carbon nanotubes can be treated in a solution of nitric and sulfuric acids to create functional groups on the carbon

nanotubes (Cooper, 0124). Cooper is not drawn merely to washing with an acid (Cooper, 0038; 0046; 0124-0127; 0131). It is noted the Liu reference submitted by Applicants is illegible.

3. Acknowledgment is made of Applicants' arguments that Khabashesku does not sidewall functionalization while the carbon nanotubes are dispersed in acid (Applicants' Response, 7/9/10, p. 14-15 and 18-26). Applicants' arguments re Khabashesku are persuasive to the extent Khabashesku does not disclose the carbon nanotubes functionalized in the same acid solvent as they were initially dispersed in. Therefore, the rejection has been withdrawn. However, upon further consideration, a new ground(s) of rejection is made over Khabashesku et al. (US 7,125,533) in view of Davis et al. (*Macromolecules*).

4. Acknowledgment is made of Applicants' arguments that Dyke teaches solvent-free functionalization of carbon nanotubes (Applicants' Response, 7/9/10, p. 15-17 and 19-26); however, such arguments are not convincing. Dyke discloses dispersing carbon nanotubes in an acid such as H_2SO_4 to form dispersed carbon nanotubes (Dyke, p. 1156; Scheme 1). While Dyke does not disclose the acid as a solvent (and actually teaches a "solvent-free" process), calling the acid a "solvent" is a matter of semantics. The H_2SO_4 of Dyke would be an "acid solvent" to no less an extent than that of the instant application. The acids are not reactants; the carbon nanotubes, 4-substiuted aniline, and nitrite are reactants. The fact that the carbon nanotubes combined with the acid, aniline, and nitrite formed a paste does not mean the nanotubes are not dispersed in the paste. Paste would just imply a more viscous combination.

5. Applicants' arguments filed July 9, 2010, with respect to the rejection over Niu (Applicants' Response, 7/9/10, p. 16-17) have been fully considered and are persuasive in view of Applicants' Claim amendment. The corresponding rejection has been withdrawn.

6. Acknowledgment is made of Applicants' argument that Cooper does not teach reaction of diazonium salts with carbon nanotubes (Applicants' Response, 7/9/10, p. 24-25); however, such argument is not convincing. None of the Claims Cooper was used to reject (**Claims 1, 2, 4, 5, 7, 8, 10, 12, 15 and 30**) require reaction of diazonium salts with carbon nanotubes.

7. Acknowledgment is made of Applicants' argument that the double patenting rejection over U.S. Patent No. 7,459,137 is in error because U.S. Patent No. 7,459,137 teaches reaction in the absence of a solvent (Applicants' Response, 7/9/10, p. 26-27); however, the examiner respectfully disagrees. While **Claim 1** of U.S. Patent No. 7,459,137 does recite "reacting said plurality of carbon nanotubes at the sidewall carbon atoms with an organic functionalizing agent in the absence of a solvent," the organic functionalizing agent is further limited to "a reactive diazonium specie" (**Claim 11**) generated from an aryl diazonium salt (**Claim 12**), wherein the diazonium specie is generated in situ from an aniline derivative and an inorganic nitrite in the presence of an acid (**Claim 20**) selected from the group consisting of sulfuric acid, acetic acid, hydrochloric acid, nitric acid, phosphoric acid, toluenesulphonic acid, trifluoroacetic acid, and combinations thereof (**Claim 22**). Thus, if the carbon nanotubes of U.S. Patent No. 7,459,137 are sidewall functionalized using a functionalizing agent in the presence of an

acid (**Claim 20**) selected from the group consisting of sulfuric acid, acetic acid, hydrochloric acid, nitric acid, phosphoric acid, toluenesulphonic acid, trifluoroacetic acid, and combinations thereof, calling the acid a "solvent" is a matter of semantics. The oxoacid of U.S. Patent No. 7,459,137 would be an “acid solvent” to no less an extent than that of the instant application.

Conclusion

8. Applicants’ amendment necessitated the new ground(s) of rejection presented in this Office action. Accordingly, **THIS ACTION IS MADE FINAL**. See MPEP § 706.07(a). Applicants are reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire THREE MONTHS from the mailing date of this action. In the event a first reply is filed within TWO MONTHS of the mailing date of this final action and the advisory action is not mailed until after the end of the THREE-MONTH shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the date of this final action.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to BRITTANY M. MARTINEZ whose telephone number is

(571) 270-3586. The examiner can normally be reached on Monday-Friday 8:30AM-5:00PM.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Stanley Silverman can be reached on (571) 272-1358. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

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